Soil erosion and conservation - A case study in the dry zone of Sri Lanka

P.B. Dharmasena
Field Crops Research and Development Institute, Maha Illuppallama, Sri Lanka

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ABSTRACT

Deterioration of land resource in the dry zone is a threat to agricultural production in Sri Lanka especially the production of coarse grains, pulses and vegetables. Most of the dry zone soils are highly erodible and rainfalls are more erosive compared to the upcountry rains. Although the problem of soil erosion has been well recognized in the dry zone and effective conservation measures have been clearly identified, still severe land degradation is taking place in dry zone farmlands due to unattended soil erosion.

Soil conservation measures have been introduced to dry zone rainfed farmers through the extension arm of Department of Agriculture, Provincial Departments of Agriculture and almost all the dry zone development projects implemented during the past. Soil conservation bunds and drains, tree and grass hedges, mulching, in-situ rainwater harvesting and watershed management programmes are the most important among them. However, it has now been realized that a more systematic approach is needed to achieve sustainable production from these lands. Most important steps are: mapping affected areas; making recommendations; planning and implementation of complete packages of sustainable farming and awareness creation among the general public on relevant Acts, policies and regulations.

***Keywords*: Land degradation, Conservation bunds, watershed management, rainwater harvesting**

INTRODUCTION

Land resource in the dry zone of Sri Lanka utilized for agricultural purposes tends to deteriorate and loosing its production potential mainly due to rain erosion and continuous removal of nutrients. During last five decades, the extent of forest has drastically declined due to colonization and shifting cultivation (*chena*). Further continuing of forest clearing is not acceptable as the present forest cover is diminishing below the threshold level to maintain the ecological balance. Thus, the land already cleared in the dry zone must be put into sustainable productive cultivation arresting soil erosion while adopting water conservation strategies. Although the dry zone lands have been subjected to degradation still about 80 percent of Sri Lanka's coarse grains, pulses and vegetables are produced on these lands. Due to low soil fertility crop yields are far below their potentials and as a result farmers gain very low profits. In brief this degraded land resource at present is not capable of performing any productive farming under rainfed situation mainly due to soil moisture deficit and deterioration of physical, chemical and biological properties of soil.

Dry zone covers 2.89 million hectares (60 %) of the country's land mass and the predominant great soil group; Reddish Brown Earths (Rhodustalfs) occupy in 56 percent (1.61 million hectares) of it's lands. Characteristics of this soil have been studied in detail due to its extensive existence as agricultural lands. Rainfed agriculture is mostly practiced on this land and has caused a severe erosion problem. Abundance of soils in the dry zone is given in Table 1.

Soil erosion

Physical structure of dry zone soils is fairly good. However, most of the dry zone soils tend to undergo a high erosion risk once the jungle cover is removed. Soil erosion has been estimated from plot measurements at Maha Illuppallama, under various conditions. In cotton-cultivated plots without any conservation measures, the annual soil loss was 22.2 t/ha. Even in a sorghum/pigeonpea inter-cropped plots soil was lost at the rate of 21.3 t/ha. Dharmasena (1992a) reported that soil erosion in a maha season could be as high as 54 t/ha from chena lands in the rhodustalf region. Wickramasinghe and Premalal (1988) observed that the annual erosivity in the dry zone region is higher than that in the upcountry mainly due to high percentage of erosive rainfall, which occur in the low country dry zone. About 70 percent of yala rainfall and 50-55 percent of maha rainfall are erosive (Dharmasena1992b). Annual erosivity in the central dry zone ranges from 116 t.m/ha (Maha Illuppallama) to 162 t.m/ha (Kantale). However, 55-65 percent of annual erosive rains occur during the maha monsoon. Erosion risk is high in low elevated areas (Table 2). Spatial variation of potential erosion is not only due

Table 1. Dominant soil groups in the dry zone and their relative abundance in Sri Lanka

Soil type	Great group	Extent ('000 ha.)	Percentage
Reddish Brown Earths	*Rhodustalfs*	1610	24.6
Low Humic Gley Soils	*Tropaqualfs*	950	14.5
Non Calcic Brown Soils	*Haplustalfs*	163	2.5
Red Yellow Latosols	*Haplustox*	320	4.9
Alluvial Soils	*Troaquents, Ustifluvents, Tropofluvents*	450	6.9
Solodized solonetz	*Natraqualfs*	210	3.2
Regosols	*Quartzipsamments, Ustipsamments*	190	2.9

Source: Panabokke, 1988

Table 2. Mean annual erosivity in selected locations of the dry zone

Location	Elevation (m)	Mean annual Rainfall (cm)	Mean annual Erosivity: EI_{30}(t.m/ha)
Anuradhapura	91	145	126
Galgamuwa	91	145	126
Horowpothana	64	164	148
Kantale	76	176	162
Maha Illuppallama	138	139	116
Maradankadawala	134	148	129
Polonnaruwa	61	170	155

Source: Dharmasena, 1992 b

to erosivity but also due to slope changes. Undulation of the topography can make large variations in the erosion even within a single micro-watershed (Table 3). This calls for the adoption of mechanical soil conservation measures to take care of the slope effect as the most essential and initial step of soil conservation in the dry zone. The months, March and September would be vulnerable for high erosion risk as arable lands are bare and barren because of clearing of land for seasonal cultivation in these two months.

The reduction of forest cover from half to less than quarter in Sri Lanka during last fifty years more than anything else gives the most clear historical evidence of soil erosion. This is primarily due to colonization and rice land development under major irrigation schemes and opening of new lands for chena cultivation in the dry and intermediate zones.

Table 3. Potential annual soil loss in rhodustalfs

Location	Potential annual soil loss (mt./ha) Land slope (%) 2	4	6
Anuradhapura	27	52	84
Galgamuwa	26	51	83
Horowpothana	31	61	99
Kantale	34	66	108
Maha Illuppallama	25	48	78
Maradankadawala	28	53	87
Polonnaruwa	33	64	104

Source: Dharmasena, 1992 b

Soil erosion is a real threat for agricultural production mainly due to two reasons. First, it takes longer period of time even for scientists to recognize that the land is being degraded due to soil erosion. For example, the work reported by Joachim and Kandiah (1948) indicated that chena cultivation would not lead to reduction in soil fertility significantly and farmers abandon chena lands because of increased weed problem. This conclusion was based on short term observations. It is important to note that one of the indicators of land degradation is the resurgence of obnoxious weeds. Second reason is the soil erosion problem which is usually addressed by looking at the consequences rather than investigating and treating the real cause of problem. Two well known examples are that the treatment of low soil fertility and soil compaction due to soil erosion are treated with application of inorganic fertilizer and tillage operation respectively, rather than attempting to control the technical and non-technical factors of soil erosion process. Although the nature of the soil erosion problem is well understood, its hazardous effects are not properly recognized.

The mechanics of soil erosion applicable for dry zone conditions in Sri Lanka is well understood. During last five decades since the inception of Kurundankulama Dry Farming Project, conservation of soil has been a concern of the farming system researchers. Research findings on rainfall erosivity and soil erodibility have been well documented. Various models have been developed to simulate the likely incidence of erosion, as affected by agronomic as well as engineering measures to mitigate the problem and farming system approach to productive and sustainable management of dry zone farm lands. Agricultural development projects have emphasized soil conservation as a major component in their work plans. However, severe land degradation is taking place in dry zone farmlands due to unattended soil erosion.

Few questions arise in finding the real solutions to the problem of soil erosion are,

- Do we have sound technology to control soil erosion?
- Why farmers do not realize the danger if cultivated without adopting soil conservation measures
- Would farming be profitable, if the soil conservation is integrated to the existing practices?
- What the extension agencies could do to make the soil conservation a reality?
- How the Government could share the responsibility of conservation of land resource with the land user?

Process of successful implementation of soil conservation programs must include clear explanation to the above questions.

Soil conservation

Soil erosion has been considered the most important problem to be addressed in the process of development of rainfed agriculture in the dry zone of Sri Lanka by almost all development projects implemented during the past. During the last decade IRDP, PRDP and SCOR (IWMI) in the NCP, DZPRDP (GTZ) in NWP and various development projects implemented in other dry zone districts have made tremendous attempts to conserve agricultural lands, catchments of reservoirs and stream bank reservations. Most of them were implemented through community participatory approach. Technical guidance has been provided by the Department of Agriculture and main aspects are briefly discussed below.

Soil conservation bunds and drains

Mechanical conservation has been considered as the main aspect of soil conservation by many implementing agencies. Bunds are demarcated on sloping lands with simple tools mostly by field extension workers or trained farmers, and land user is asked to do soil works with or without incentives. Recommendations made for three different soils found in the dry zone are given in Table 4, 5 and 6.

Tree and grass hedges

Table 4. Recommendations for conservation bunds and drains on Reddish Brown Earth soils

Land slope (%)	Spacing (m)	Runoff (m^3/hr)	Bund height (cm)	Drain	
				Depth (cm)	Top width (cm)
<2	15	165	30	15	70
2-4	10	100	25	10	50
4-6	7	75	25	10	50
6-8	6	60	20	10	40
8-10	5	50	20	10	40

Source: Dharmasena, 1992 a

Table 5. Recommendations for conservation bunds and drains on Non Calcic Brown soils

Land slope (%)	Spacing (m)	Runoff (m^3/hr)	Bund height (cm)	Drain	
				Depth (cm)	Top width (cm)
<2	15	35	30	15	40
2-4	10	20	25	15	40
4-6	8	15	20	10	35
6-8	6	10	20	10	35
8-10	5	10	20	10	30

Source: Dharmasena, 1992 a

Table 6. Recommendations for conservation bunds and drains on Red Yellow Latosol and Regosol soils

Land slope (%)	Spacing (m)	Runoff (m^3/hr)	Bund height (cm)	Drain	
				Depth (cm)	Top width (cm)
<2	50	50	30	15	40
2-4	25	30	30	15	40
4-6	20	20	25	10	35
6-8	15	15	20	10	35
8-10	10	12	20	10	30

Source: Dharmasena, 1992 a

By some projects *gliricidia*, *vetiver* or *citronella* hedges were introduced to control soil erosion and restore the already degraded lands. Purpose of this practice was to improve the physical tilth of the soil, maintenance of the soil nutrients level, suppress weeds, which are difficult to control and reduce the evaporative demand by creating a low temperature and high humid micro-climate at the ambient crop layer. Farmers were expected to maintain these hedges by regular pruning.

Recent investigations showed that *citronella* hedge is more effective than *vetiver* hedge in soil erosion control, biomass production, yield increase of the companion crop and in weed control. It was also found that biomass production of *citronella* is reduced when it is grown with *gliricidia*. However, total biomass production has increased by 47 percent due to inclusion of citronella. Grass-tree alley cropping achieved 45 percent yield increase of sesame over conventional alley cropping when the mulch was incorporated by tilling the soil. This must be mainly due to citronella mulch because *citronella* hedge can made 41 percent yield increase over conventional alley cropping. However, these differences were not significant with surface mulch application. Thus, it is concluded that tree alley cropping can be improved by inclusion of a grass like *citronella* along the same hedgerow (Dharmasena 1996).

Watershed management approach

Shared Control of Natural Resources (SCOR) Project implemented by IWMI had a participatory agricultural development program on watershed basis. The project was operated in the Huruluwewa major reservoir watershed and in its command area. Several conservation aspects were attempted under the project such as reforestation of small tank catchments, soil conservation in homesteads and rainfed farming areas, conservation of Yan-oya reservation by planting bamboo and diversifying to perennial tree farming etc.

In-situ rainwater harvesting

A micro-scale rainwater harvesting system referred to as 'eyebrow bund and pitcher system' was adopted by several projects (NWP-DZPDP, NCP-PRDP, SCOR, CARE-DZADP etc.) for establishment of fruit trees in the dry zone rainfed areas. Soil erosion control is an in-built component of this crop establishment package (Dharmasena, 2001).

The issue of soil erosion is in many instances addressed by controlling water erosion. However, there are other factors related to the soil erosion process that need similar attention in planning programs. They are: restoration of already degraded lands; arresting soil fertility decline; controlling removal of natural vegetation; conservation of stream bank reservations; drainage improvement; reducing pressure on the use of lands for agriculture; awareness creation among all layers of the human profile dealing with the problem; and imposing effective regulations.

Following actions need to be taken in attempting to address the soil erosion problem in the dry zone.

- Mapping of all affected, vulnerable and problem existing areas.
- Classification of lands on erosion severity.
- Recommendation on soil conservation measures and land use types for each land category according to the level of erosion severity
- Restoration programs for already degraded lands
- Awareness creation on soil conservation act and regulations.
- Implementation of programs on reforestation of reservoir catchments and conservation of stream bank and reservoir reservations through community participatory approach
- Promotion of sustainable farming in both rainfed and irrigated agriculture.

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